

Activity #2

Source moves
left and right

Coils move
left and right



Title: An Investigation into Longitudinal (Compressional) Waves (Teacher's annotated version)

Note to students: All answers and diagrams are to be made on a separate answer sheet. Make no marks on this paper.

The terms *longitudinal* and *compressional* are used interchangeably to refer to the type of wave under investigation in this activity.

(Lab teams of three students are required for this activity.)

National Standards addressed: *INTERACTIONS OF ENERGY AND MATTER*

Waves, including sound and seismic waves, waves on water, and light waves, have energy and can transfer energy when they interact with matter

Purpose:

- To create longitudinal waves in a “Slinky[™]” –type spring
- To become familiar with the nomenclature associated with longitudinal waves
- To visualize the processes by which waves carry energy from one point to another

Materials: Large diameter spring, meter stick, string (5 cm)

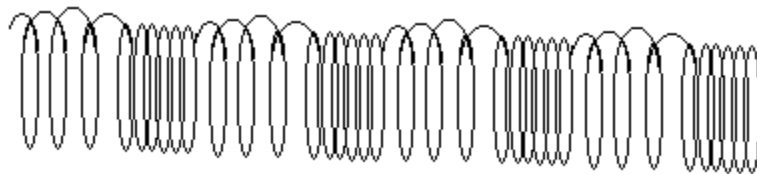
Materials Sources: large diameter spring: Frey Scientific, 100 Paragon Parkway, P.O. Box 8101, Mansfield, OH 44903---2002 catalogue, pg. 761, **Economy Wave Demonstrator Set**, # 15578650, \$11.35

Meter stick: Frey Scientific, 100 Paragon Parkway, P.O. Box 8101, Mansfield, OH 44903---2002 catalogue, pg. 691, **Hardwood Meter Sticks**, # 15015366. \$2.95

Procedure:

1. Place the Slinky[™] spring on your lab counter top and have your partner hold one end while you stretch the spring SLIGHTLY (so there is a spacing of about 1 cm between each of the coils) from the other end. Now snap your hand TOWARDS the other end of the spring about 20 cm and then stop. Describe what you see traveling down the spring. (The students should be aware that the entire spring need not be stretched. If space is limited, one half of the spring can be stretched...with similar results observed.) A region where the coils are closer together than normal is produced which then travels down the length of the spring.
2. Now snap your hand AWAY from the opposite end of the spring about 20 cm and then stop. Describe what you see traveling down the spring. The students should observe a region where the coils are further apart than normal being produced which then travels down the length of the spring.
3. Now combine the movements described in steps 1 & 2 above and repeat continuously about two times per second. You are producing **longitudinal** or **compressional waves**. Make a sketch of the spring's appearance while producing these waves. Using your textbook or visiting the website:
<http://members.aol.com/nicholashl/waves/movingwaves.html> ,

label the regions where the coils are spaced closer than normal and the regions where the coils are spaced further apart with the appropriate name. You can use a diagram similar to the one below.



Students should label the regions where the coils are closer together than normal *compressions* and the regions where the coils are further apart than normal *rarefactions*.

4. While producing TWO waves per second (as in step #3 above), measure and record one wavelength in centimeters (which is the distance from one compression to another, or from one rarefaction to another).
5. While producing FOUR waves per second (as in step #3 above), measure and record (in centimeters) one wavelength. **Students should report a wavelength approximately one-half that recorded in # 5 above.**
6. From your observations in #4 & 5 above, complete the following statement: As the frequency of a compressional (longitudinal) wave increases, the wavelength _____. (increases, decreases, remains about the same) **Students should observe that the wavelength DECREASES as the frequency increases.**
7. Tie a small string to one coil of the large spring and describe its motion as waves travel down the spring. Does the string move parallel (in the same direction) to the wave motion? Does it move perpendicularly (at 90°) to the wave motion? **The string moves parallel to the motion of the spring.**
8. Describe any similarities of how a transverse wave (from Activity #1) and a longitudinal wave get produced. **Both waves need a source of energy (vibratory hand motion) in order to be produced in the springs.**
9. Describe at least one difference between a transverse and a longitudinal wave. **Students may mention that the APPEARANCE of the waves is different or that they travel along the springs at different SPEEDS.**

At this point, teachers could mention that waves found on the electromagnetic spectrum (gamma through radio waves) all travel via transverse waves best through a vacuum. The only common energy which is propagated by compressional (longitudinal) waves is sound energy. It travels best through solids, slower through liquids, poorest through gases and not at all through a vacuum. (See Teacher Demo-Activity #3)

TECHNOLOGY INTEGRATION: The websites below offer entertaining enrichment activities to enhance the comprehension of the concepts covered in this laboratory activity:

- <http://surendranath.tripod.com/Lwave/Lwave01.html> allows the user to vary the frequency and amplitude of a longitudinal wave.
- <http://www.physicsclassroom.com/Class/sound/u1l11b.html> demonstrates sound as a longitudinal wave.
- <http://www.physicsclassroom.com/Class/sound/u1l12d.html> discusses and demonstrates how the human ear receives sound waves.
- <http://curry.edschool.virginia.edu/teacherlink/content/science/instructional/longitudinal/> Students will investigate and understand how to use models of longitudinal waves to interpret wave phenomena.